

## WTB SNOW MELT SYSTEM INCIDENT REPORT

### Introduction

Washington Trust Bank (WTB) retained Coffman Engineers, Inc. to investigate the root cause failure of the snow melt system at the Main Branch in downtown Spokane. Stephen Helms, P.E., author this report. I have over 40 years of experience in the consulting engineering field. My qualifications include a BSEE from WSU in 1971 and licensed as a Professional Engineer since 1977. I owned DEI Electrical consultants for 30 years before merging with Coffman Engineers 2 years ago. Engineering of snow melting systems has been a component of engineering services I have provided over the term of my career. I have also provided engineering for electrical systems that involve close proximity to animals, in particular livestock, and I am aware of the particular susceptibility of animals to electric current.

### Washington Trust Bank Snow Melt System Incident

I received a telephone call from Mr. Keith Erhart, the Facilities Manager of Washington Trust Bank on Thursday, February 7, 2019. Mr. Erhart described to me the tragic accident that killed Mr. Zack Harper's dog "Hank" outside the main branch of Washington Trust Bank ("WTB") in downtown Spokane located at 717 W. Sprague Avenue. The incident occurred around noon on February 5, 2019. Mr. Erhart told me that Hank might have been electrically shocked while walking on the sidewalk on the south side of the building near the parking entrance. He told me that two individuals – the building engineer and Mr. Harper, reported that they were shocked as they attempted to move Hank. Mr. Erhart indicated that the Bank has an electric sidewalk heater in the driveway of the parking garage and it is one of four sidewalk heaters located at the ingress/egress points of the building. He also indicated that at the time of the incident, the area was wet with melted ice/snow combined with deicer used in the area. Mr. Erhart told me that he was present at the scene and had the engineer shut down all power to the sidewalk heaters as soon as there was an indication that there was electrical shock occurring, approximately within 15 minutes of Hank being shocked.

Mr. Erhart informed me that there were other sources of electricity in the area, including a metal city light pole and electricity for an automatic gate to the parking garage. The afternoon of February 5<sup>th</sup> the Bank and Power City Electric turned the power back on to test the driveway area. The test showed voltage emanating from the sidewalk in the approximate area that Hank stepped. Mr. Erhart later provided me digital photographs of the test to confirm the readings.

Mr. Erhart told me that the morning of February 6, 2019, he was contacted by an engineer from Avista who tested Avista's local vaults and equipment. He reported to Mr. Erhart that they found no issues with Avista's equipment. Based on the investigations that WTB carried out and the confirmation from Avista that there were no issues with its grid, the Bank adopted the working scenario that some type of damage to the heater system buried in the driveway allowed electricity to escape. The presence of water contaminated with deicer created

conditions where the resistance in the concrete was reduced and the electricity shocked Hank when he stepped on the area.

### **Washington Trust Bank Requests for Investigation**

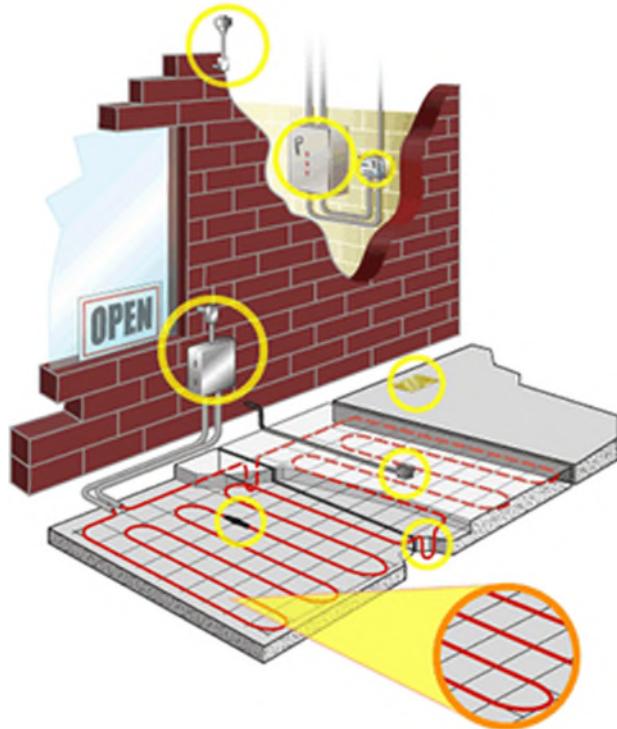
The Mr. Erhart requested that I provide an opinion on the following issues:

- (1) Is the Bank's working scenario plausible or likely;
- (2) What factors would have been involved that could have led to an electrocution of Hank when humans in the area had traversed the same location with receiving injurious electrical shocks;
- (3) In my experience and knowledge, was there a recall, upgrade or maintenance requirement on this equipment that the Bank or its building manager may have missed;
- (4) Are sidewalk heaters inherently dangerous and have they been improved since the installation of the WTB heaters in 1973;
- (5) Given the situation would I have recommendations regarding sidewalk heaters and potential electrocution moving forward.

### **Electric Snow Melt System**

Mr. Erhart indicated to me that he went back to the building blueprints and discovered that the electric snow melt installed at WTB was installed in 1973 when the building was built. He told me that the plans indicate that the system was a Nelson Electric Model 400 manufactured by Nelson Electric Company. There is no way to be certain that this was the exact system, but I have no reason to doubt that it is not. Mr. Erhart later sent me digital photographs of the temperate sensor and junction box; the equipment would be compatible with the Nelson system. This system was sold and placed in buildings during the 1970s. There were cheaper options available; therefore, this type of system was rare. However, I engineered sidewalk heaters using this system for Washington State University in the 1980s. To my knowledge, it was removed about a decade later to make room for another building.

The system uses Mineral Insulated ("MI") cables, which consist of two copper conductors in an incoloy alloy tube with magnesium oxide insulation filling the tube. Incoloy is used as the sheath due to its high resistance to corrosion characteristic at high temperatures. Each cable is approximately 3/8" in diameter. The MI cables are cast into the concrete when the slab is poured. When expansion joints are crossed a "cold" (non-heating) jumper cable is spliced onto the ends of the two MI cables and a loop under the expansion joint is installed. The same is true of the power feed. A "cold" power feed cable is installed from the circuit breaker in the snow melt panel. Control of the snow melt panel is from a contactor that turns on or off the entire panel load. A simple diagram on how a typical snow melt system is laid out is provided for your reference:



## Probable System Failure Causes

In my opinion, it is most likely that Hank's death was caused an electrical current through his body that passed through his heart and disturbed his normal heart rhythm. It is my understanding that this opinion is consistent with what Mr. Harper's veterinarian told Mr. Harper was the likely cause of death. Based on the information I have, this current was likely due to a break in the insulation of the snow melt system that caused a voltage gradient in the concrete where Hank was walking.

The snow melt system at WTB is 45 years old. It is most likely that a splice joint failed or the MI cable sheath has corroded away. With the highly conductive water that was present a stray voltage gradient was established which led to the problem.

There were several factors involved. The concrete was wet and had deicer on it. The highly ionized water increased the conductivity of current to a level where the shock threshold was fatal. If the concrete had dried out with the applied heat the shock level would probably not have been fatal due to an increased contact resistance. The deicer increased the conductivity of the water. Salt water is 500 times more conductive than fresh water.

Based on my experience, four-legged animals are particularly susceptible to a voltage gradient on the ground than bipeds. When I design agricultural buildings like those at the fairgrounds, I must install an equipotential ground plane. Where the animals enter and exit the building a low gradient ground plane is designed. If one is not present cows may balk at entering the

building. They feel the small voltage difference between there front and back legs. The current path through a four-legged animal goes through the heart region thus significantly lowers the fatal level of gradient ground voltage. Bipeds – such as humans – are likely to wear shoes, which are good insulators and current path from a human's legs does not pass through heart region. A human walking over the area would be unlikely to experience any sensation and if he or she did, it was unlikely to be fatal or cause injury. This is consistent with the report that although Mr. Harper and the building engineer felt a shock from the sidewalk, neither was injured.

### **System Installation, Upgrade and Maintenance**

The snow melt system that failed at WTB was installed in 1973. It met National Electrical Code (NEC) requirements at that time. Normal inverse time non-ground fault circuit breakers were installed. In 1993 the NEC added section 426-53 and later in 1996 incorporated that section in section 426-28 ("Fixed outdoor electric deicing and snow melting equipment"). The new section required that all circuit breakers used for fixed snow melting and deicing equipment utilize GFPE circuit breakers. GFPE (Ground Fault Protection of Equipment) circuit breakers sense ground faults (leakage current) and trip at values above 30 millamps. The GFPE circuit breakers are for protection of equipment.

Direct maintenance cannot be performed on the cables. Snow melt systems are entirely concealed after they are installed. Maintenance is usually only done when a zone quits working and that consists of replacing the defective heated slab section. Nothing in the NEC required WTB to update its system or to retrofit its system with a GFPE. In addition, this is a very isolated incident. Prior to this instance, I had never heard of a damaged ice melt system causing a fatality or serious injury in a human or animal. Therefore, prior to this situation, I would not have advised my clients of a need to replace, retrofit, or test their systems. I am not aware of any professional guidelines that require any testing of any ice melt systems for current leakage after initial insulation. Mr. Erhart indicates that WTB has never received any complaints or concerns about the ice melt system. With no indication of a problem, there would have been no reason to test the system.

### **Recommendations**

What occurred in this case will only occur on systems that were installed prior to the 1993 NEC (25 years ago) code going into effect. Areas that contain ice melt systems are often torn up and the systems are either replaced or discarded. It happens here that the sidewalk was not replaced. Therefore, if installed correctly, newly installed systems are safe. Only those older than 1993 would have this failure mode. All the newer systems will trip off any circuit that has a ground fault. I recommend any snow melt system installed prior to 1993 be retrofit with GFPE circuit breakers. Additionally, any system that has had repairs should be checked to verify that GFPE circuit breakers are present on all circuits.